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CHARACTERISING THE SPAWNING HABITATS OF SARDINE FROM THE NORTHERN COAST OF SPAIN IN APRIL 2008

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Abstract

This document presents the results of the analysis from sardine (*Sardina pilchardus)* egg densities in relation to environmental (temperature, salinity) and geographic (longitude, depth) variables. Data were obtained from the SAREVA0408 ichthyoplankton survey conducted by IEO (Instituto Español de Oceanografía*)* in April 2008. Quotient analysis, temperature-salinity plots and time distribution for eggs per stage of development, were employed to study spawning habitat of the sardine off north Spanish Atlantic, Cantabrian waters and south of the Bay of Biscay.

Introduction

A DEPM survey has taken place in 2008 covering the north Spanish Atlantic, Cantabrian waters and south of the Bay of Biscay area in order to provide an estimate of the spawning stock biomass of the Atlantic-Iberian sardine. The survey was carried out by IEO in April 2008 on board RV *Cornide de Saavedra* (SAREVA 0408). Sardine eggs densities, environmental (temperature and salinity) and geographic (longitude and depth) data, resulting from SAREVA 0408 survey have been used to describe the spawning habitat of *Sardine pilchardus* in the sampled area.

Some basic data exploration techniques borrowed from what is called spawning habitat characterization will be of great help in data exploration to known the kind of GAM modelling (ICES, 2004) should perform to obtain egg production.

The combined use of the quotient and T-S analyses provides valuable insight into the spawning habitats (Checkley *et al*., 2000 and Bernal *et al*., 2007) being quotient one dimensional analysis and T-S diagrams a two dimensional analysis. The quotient plots provide a way of finding spawning preferences by comparing quotiles of egg density with any other covariate found in the survey. The T-S plots allow inference about the water masses sampled and their association with the eggs of the studied species.

Material and methods

The ichthyoplankton survey (SAREVA 0408) was carried out on board R/V *Cornide de Saavedra* from 2nd to 27th April. Samples were taken with a PAIROVET net (double CalVET). Pairovet was fitted with a CTD (Sea Bird 37) in order to obtain a profile (temperature and salinity) in each CalVET station. Moreover a continuous record of temperature and salinity (at 3 m depth) was obtained from a thermosalinometer during the survey.

In laboratory, the CalVET samples were sorted again in order to remove any remaining eggs and then all sardine eggs were classified into 11 stages of development (Gamulin and Hure, 1955).

Relationships between environmental and geographic variables and sardine egg density were explored using quotient analysis. Quotient analysis was carried out using temperature, salinity, longitude and depth as environmental and geographic variables. Bottom depth data has been transformed to logarithm scale. In quotient plots histograms represent the frequency distribution values for each class environmental variable examined and the quotient value. shachar R package (Bernal *et al.*, 2007) was used to analyse the data.

Two dimensional analysis using T-S plot has been performed to establish relationships water masses sampled (temperature and salinity) and their association with sardine eggs.

Those eggs stage whose percentage were greater than 5 % over the total sampled, have been plotted in a 24 clockface to visualize time distribution of each egg stage.

Temperature and salinity at 10 and 20 m depth from CTD and thermosalinometer recorded data, were mapping through the krigging interpolation method.

Results

Sea Surface Temperature and Salinity in the area were ranged from 11.9ºC to 15.2ºC and from 35.09 to 37.08 PSU respectively during the SAREVA0408 survey.

Quotation plot of egg densities (eggs/m^2) in relation to Longitude (Figure 1, top) shows a preference for a restricted area to the northern Galician waters. As in previous surveys, very few sardine eggs were found off the western coast of Galicia. Most sardine eggs were collected along the Cantabrian Sea and south of Bay of Biscay.

Quotient analysis for bottom depth (Figure 1,) shows most of the positive stations and the classes with quotients larger than one are on the shelf (depth < 100 m.). The largest concentration of sardine eggs was 468 eggs/0.05 m^2 was found close to the coast (51 m).

Considering the relationship among obtained eggs abundance with temperature (Figure 2, top) results from the quotient analysis did not show a clear preference for a fixed range, and there are at least five peaks in different values of temperatures (11.4, 12.3, 13.1, 14.5 and 14.7 ºC) and one peak in the quotient related to a few positive stations in 14.9 ºC. As for salinity (Figure 2, bottom) most of the eggs have been sampled in a range between 34.3 and 35.3 ‰.

The T-S plot indicates that most stations are located between 27-26 density isolines (pycnocline). T-S plot shows that the preference ranges of temperature and salinity for sardine spawning during the survey were 12 to 15ºC and 34 to 35.5 PSU (Figure 3). Stations with larger abundance of sardine eggs do not seemed to select specific water masses.

Warmer and lower salinities waters were found in the innermost sector of Bay of Biscay due to the influence of the Gironde River (Figures 4 and 5). But colder and higher salinities waters were found off the western coast due to the influence of the Eastern North Atlantic Central Water (sub-tropical origin).

The 24 hours clock plots shows the time distribution in percentage for sardine eggs in stages II, III, V, VI, VII and X. The greater percentages of eggs in stages III, V and VI were collected at 14:00 hours while the rest of stages were not showed a clear time preference (Figure 6).

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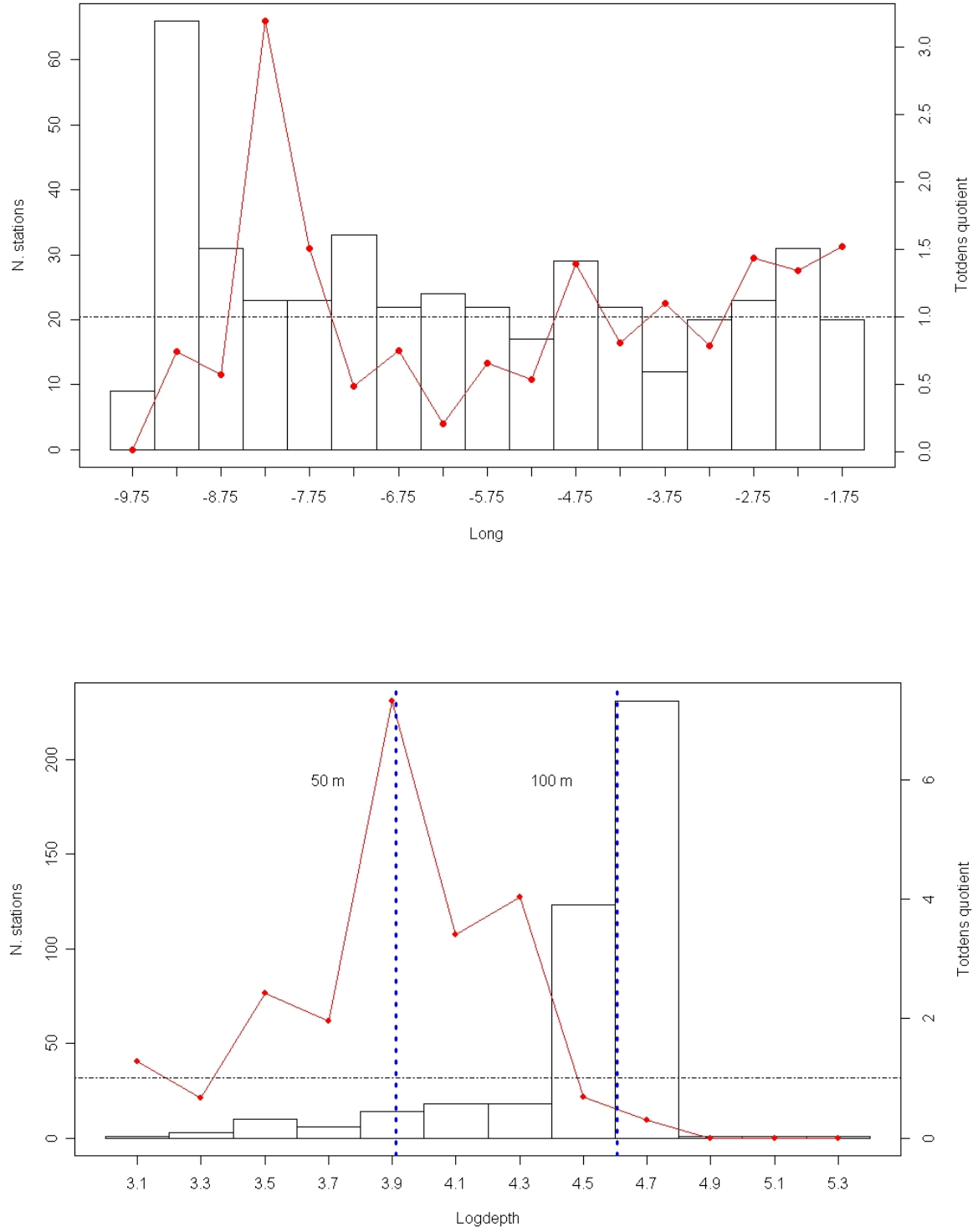

Figure 1. Quotation analysis of egg densities (eggs/m^2) in relation to longitude (top) and logarithm of the depth (bottom). The horizontal dashed line indicates a quotient value of 1. The red line represents the quotient values. Vertical blue dashed lines indicate 50 m and 100 m depth.

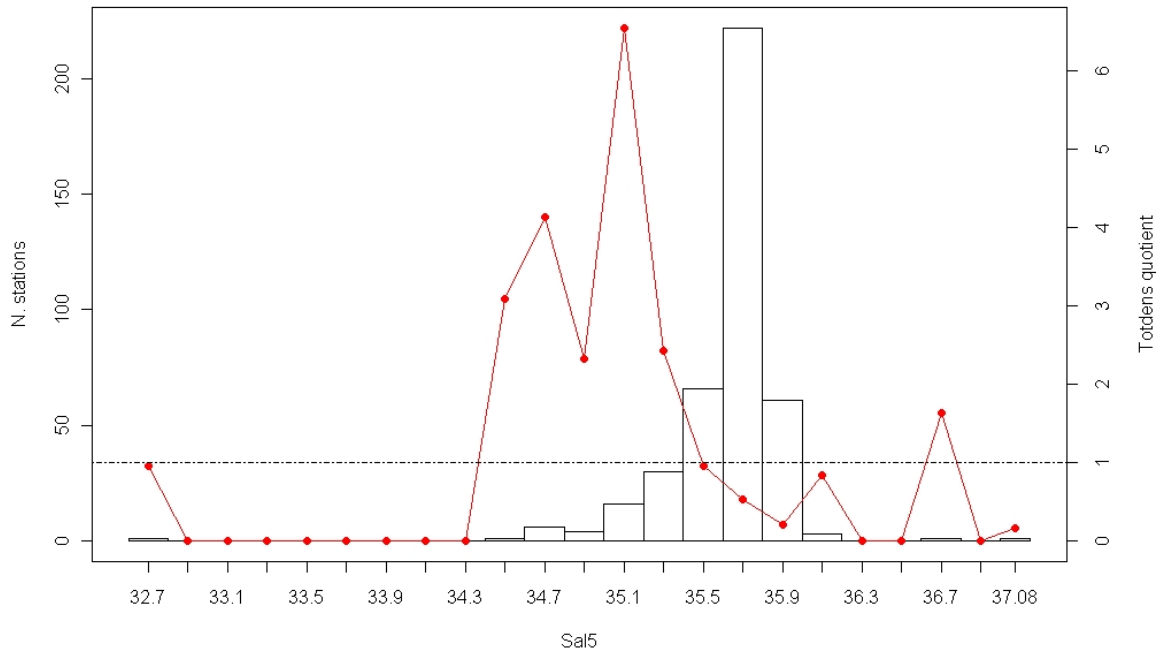

Figure 2. Quotation analysis of egg densities (eggs/m^2) in relation to temperature (top) and salinity (bottom). The horizontal dashed line indicates a quotient value of 1. The red line represents the quotient values.

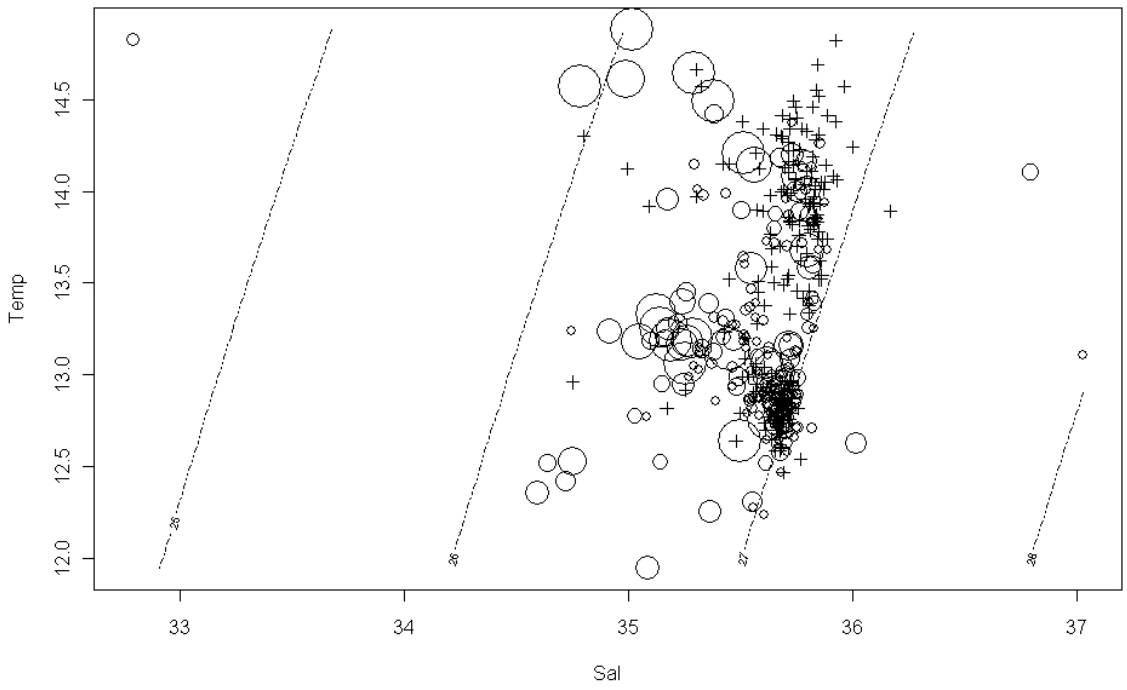

Figure 3. T-S plot. Sardine egg density (eggs/m^2) considering temperature and salinity. Size of circles is proportional to egg density. Crosses indicate stations with less than one egg. Dotted lines are iso-lines of equal water density.

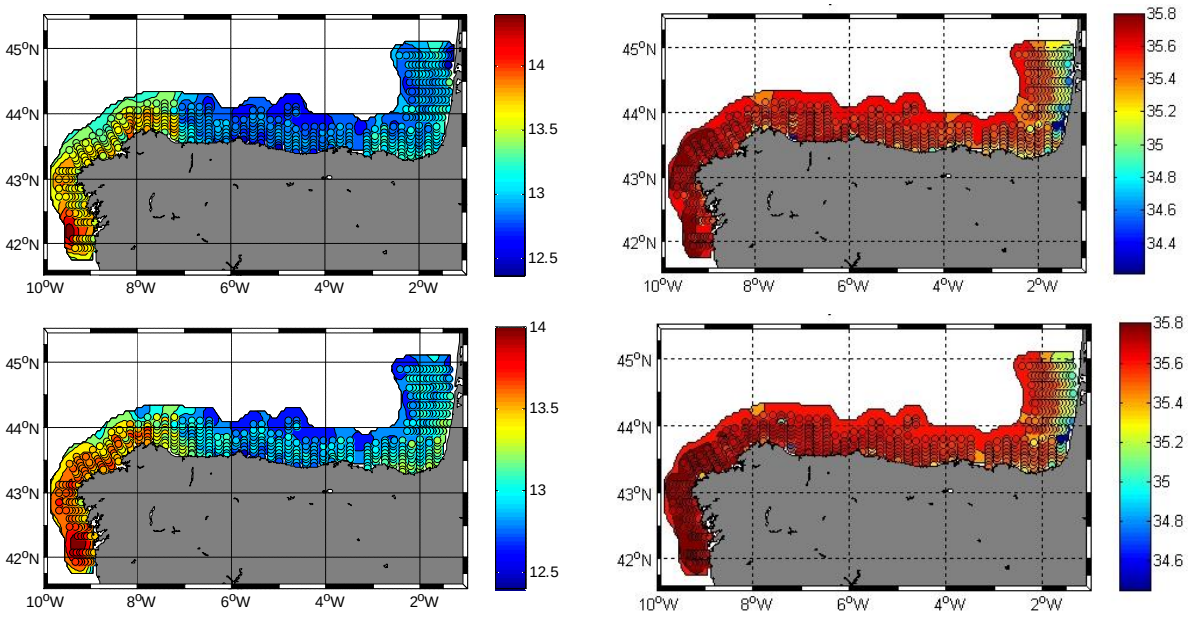

Figure 4. Temperature in ºC (left panel) and salinity in PSU (rig panel) at 10 m depth (top) and 20 m depth (bottom) obtained from the CTD.

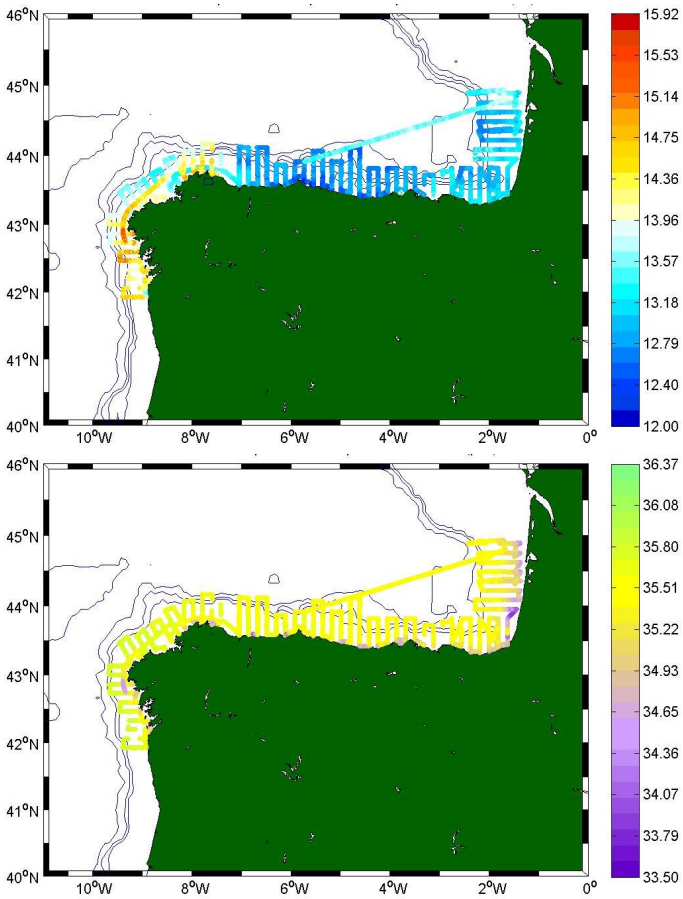

Figure 5. Continuous record of temperature (top) and salinity (bottom) at 3 m depth obtained from the thermosalinometer.

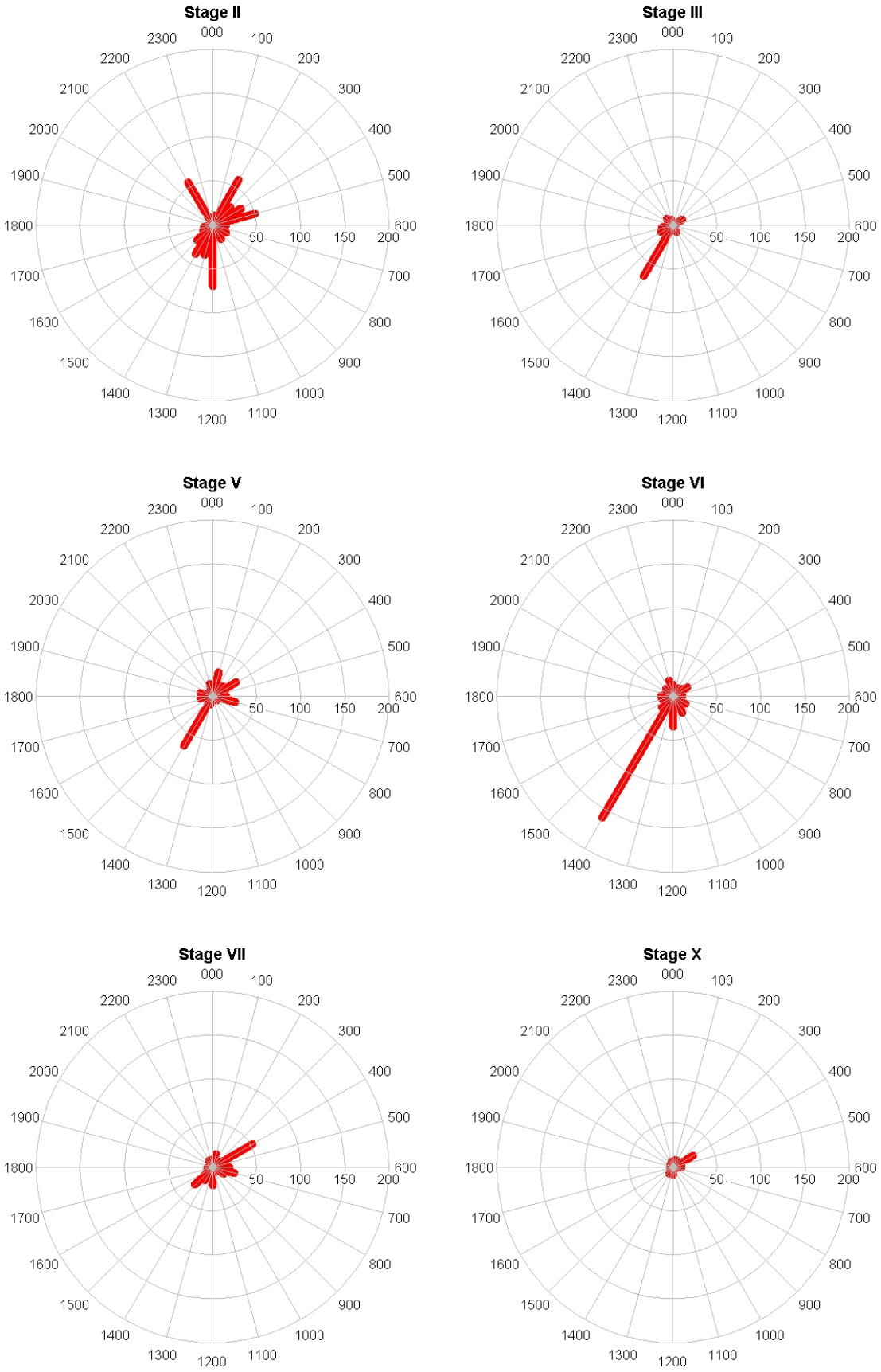

Figure 6. Number of Sardine Eggs (red lines) collected during SAREVA0408 by different sardine eggs stages according to a 24 clock face.